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LOOKING AT CEREAL VARIETIES TO HELP REDUCE WEED CONTROL INPUTS

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Summary: Improved understanding of cereal canopy shading may allow a reduction of inputs for weed management. A trial is described from the EU-funded Weed Control in Organic Farming (WECOF) project showing the relationship between wheat and weed ground cover through the season. Some varieties show good early planophile growth and ground cover and poor, erectophile, later cover, allowing late weed growth. Others show converse development and effect on weeds. Some have high ground cover throughout the season, giving consistently good weed suppression. The detailed development of the canopy is being modelled to assist in describing varietal ideotypes for appropriate weed suppression under different conditions. The aim is to produce variety identification guides for organic farmers who need more competitive crops, and for breeders to understand the key features of such varieties. This knowledge would also be beneficial for ICM and agri-environment schemes where there is a need to reduce herbicide use.

INTRODUCTION

The importance of the competitiveness of the cereal crop in weed management has been recognised by many workers. Competitiveness depends on a number of factors: quality of seed, sowing rate and row spacing, timing of emergence in relation to weeds and crop vigour and health in response to inputs and environmental factors (Davies & Welsh 2002). A range of morphological characteristics has also been shown to affect the way a crop competes. Among the cereals, the most competitive are probably oats and winter rye, followed by triticale and wheat. Bertholdsen and Jonsson (1994) (*vide* Taylor *et al* 2001) noted that barley competed with weeds mostly for below ground resources through root competition, whereas in oats and wheat competition for light appears more important (Eisele & Köpke 1997; Lemerle *et al.* 1996; Gooding *et al.* 1997). Trials at Elm Farm Research Centre in organic cereals also show that oats and triticale are more weed suppressive than wheat (Davies & Welsh 2002).

Richards (1989), amongst others, have shown that in conventional systems increased early prostrate ground cover in wheat and spring barley varieties reduced weed emergence and early growth, and these factors were associated with improved herbicide activity (Richards & Davies 1991). Eisele and Köpke (1997) confirmed that, in organic systems, wheat with planophile rather than erectophile leaves gave increased ground shading during growth, which could significantly reduce weed biomass. Cosser *et al.* (1997) showed that taller wheat cultivars such as Maris Widgeon reduced the penetration of photosynthetically-active radiation into the crop. Reducing the plant height of Maris Widgeon through introduction of dwarfing genes increased weediness. However, trials by Cosser *et al.* (1997) also showed that Maris Widgeon was not

always the best variety at suppressing weeds compared with some shorter modern varieties. Eisele and Köpke (1997) also indicate that tallness is not the only or prime factor, and that good overall shading ability is important.

The European Union funded project (QLRT-1999-31418), Weed Control in Organic Farming (WECOF), is in part attempting to evaluate the unknown relative importance of the different components of the canopy morphology, crop height and speed of development at key stages on light penetration and this ability to reduce weed growth. The aim of the project is to assist farmers in improving selection amongst available varieties, and to help breeders in identifying traits that favour weed suppression. A wide range of varieties are assessed and compared which have large differences in morphology. This allows the association of morphological characteristics with weed suppression through shading, and by mechanistic modelling, to identify ideotypes. This paper describes the results from one trial of a four-season trial series (2000-2004), utilising the data to illustrate the potential variation between varieties in weed suppression, and discusses the value of the approach for both organic and conventional systems.

MATERIALS AND METHODS

Varieties of modern winter wheat with a wide range of canopy morphologies of British and European types were sown at Coulston Farm, Haddington, East Lothian on 25th October 2001 at 450 seeds m⁻¹ at 12cm row spacing in plots of 2m x 20m replicated in four fully randomised blocks. A tall old wheat variety, Maris Widgeon, was also included along with spring wheat, Chablis and an oat, Gerald, for comparative purposes. The soil was a sandy clay loam; previous crop was spring peas and dressing of chicken manure provided adding nutrient. For this short report we describe crop cover and weed cover throughout the season, GAI and LAI (measured by Delta-T Devices Sunscan type SS1), to show the potential variation between varieties. Within the project, leaf development, shape and angles are described along with light profiles within the canopy.

RESULTS

The varieties giving greatest weed suppression at GS29 and 49 tend to have the greatest crop ground cover at GS13/21 (Fig 1), with correlation coefficients of -0.67 and -0.70 respectively. If the oat variety, Gerald, is omitted, the latter coefficient increases to -0.81. This trend continues with greater crop cover at GS29/31 (Fig. 2) correlating (-0.59) with weed cover at GS49, and crop cover at GS49 correlating (-0.76) with weeds remaining after harvest.

Fig. 3 shows the crop cover by variety at GS13/21, 29 and 49 and Fig. 4 the weed cover at GS29, 49 and post-harvest. There was considerable variation between varieties in their ground cover over the season. For example, a range of varieties show good early planophile growth and ground cover, but become more erect later, with poor ground cover (e.g. Riband and Genghis). Other varieties show more erect early growth with poor ground cover, but good late cover (e.g. Batis and the oat Gerald). Another group shows good cover at all stages (e.g. Rialto). This is reflected in weed cover, with Riband and Genghis showing good early but poor late weed suppression, Batis and Gerald showing good late weed suppression and Rialto good weed suppression throughout the season. The tall, old variety, Maris Widgeon, gave the best

later weed suppression, but the much shorter modern variety, Rialto, gave almost as good late suppression and better early suppression. Taller varieties at GS31 tended to give the best light interception (data not shown; correlation coefficient = 0.78), but this was not consistent between varieties. Light interception (%PAR) at GS31 did not show a direct effect on later weed suppression, although there was a trend for the best weed suppressors to be the best light interception (data not shown). Fig. 5 shows the LAI at GS31, with the varieties giving best weed suppression at GS49 and post-harvest having average or above LAI and the poorest with lower LAI.

DISCUSSION

The importance of early crop ground cover for weed management through the season is shown in this trial, confirming Richards and Davies (1991) results for conventional wheat. However, varieties that change their habit and have relatively reduced ground cover later in the season allow later weed growth. Some recompense for relatively poor early weed suppression is seen in some wheat varieties, and the oat variety Gerald, by good later crop cover; this is most notable in the older, tall variety, Maris Widgeon. Other varieties, such as Rialto, have consistently good cover, and despite being much shorter than Maris Widgeon, final weed levels are very similar. A range of intermediates are evident.

Light interception did not significantly correlate with weed suppression although it did with crop height, but the earliest assessment was at GS31 and there is an indication that earlier cover is just as important. Nevertheless, there was a tendency for the best weed suppressors to be the best light interceptors. Also, LAI at GS31 does appear to be related to later weed suppression.

The development of ground cover and shading of the weeds varies between varieties, and is derived from crop leaf number, development rate, size, shape and angle from the stem and the stem height. The relative importance of these factors is not yet understood, but form a key part of the WECOF project where they are being evaluated through modelling. The use of the wide range of varieties of very different morphologies allows association of individual structures and groups of structures with their impact on shading. It is the intention to model ideotypes that have appropriate shading ability for key parts of the season when weed emergence and growth is expected. This will vary with site (latitude/angle for the sun), climate and time of sowing. The farmer or breeder can then identify types that suit their practice and environment. For example, in Scotland for a late sown wheat, spring and early summer weed growth is important, but in southern Europe, winter and early spring growth is important. The period of shading through ground cover of the crop will need to vary accordingly.

For organic farming, in which weed management is perceived as a major problem, the ability to select varieties that give improved weed suppression is clear, so long as varieties show other desired qualities. However, for conventional cropping systems the availability of effective herbicides reduces the need for such selection. Nevertheless, as shown by Richards and Davies (1991), such selection may have cost benefits in terms of reduced herbicide costs. The use of such varieties may also have benefits for ICM systems and where herbicides use is otherwise reduced for specific agro-environmental schemes.

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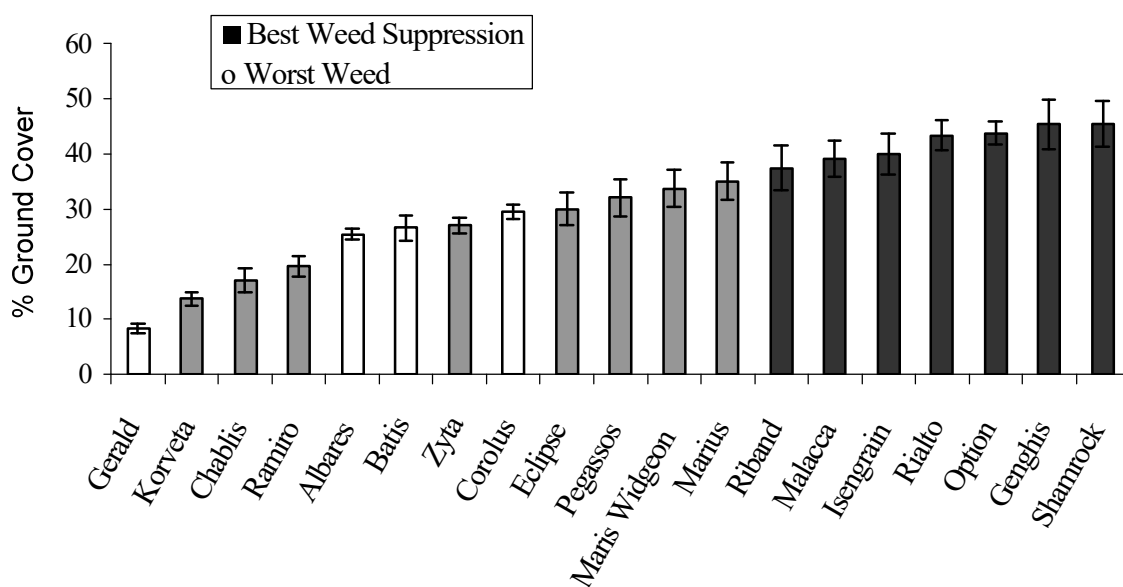


Figure 1. Crop cover for varieties at GS13/21, with darker shading indicating best weed suppression at GS29 and non-shaded, worst weed suppression (Bars = SE).

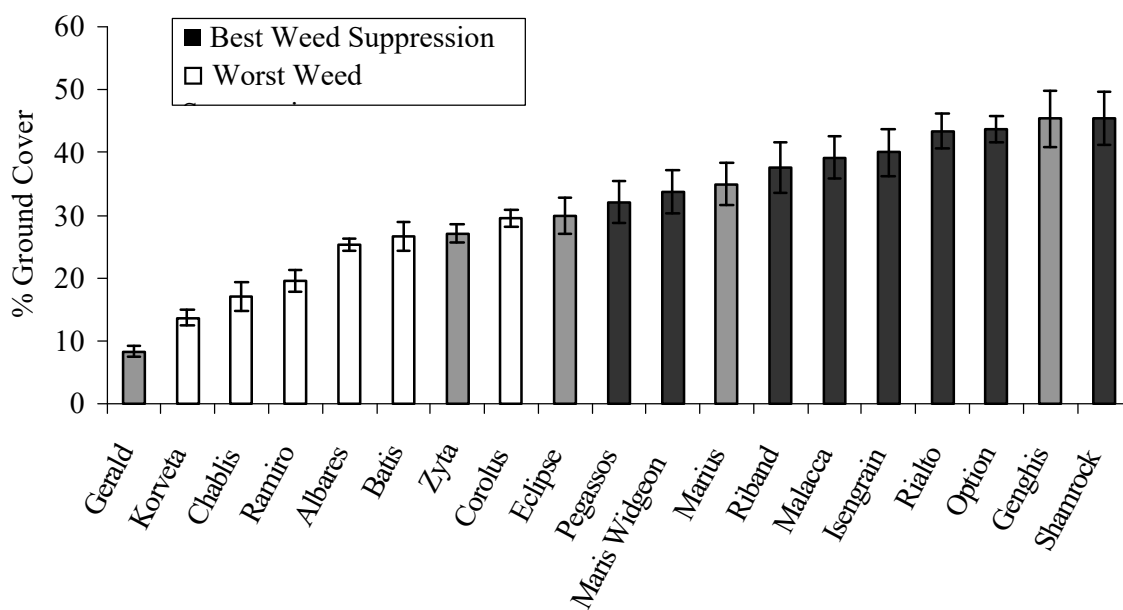


Figure 2. Crop cover for varieties at GS13/21, with darker shading indicating best weed suppression at GS49 and non-shaded, worst weed suppression (Bars = SE).

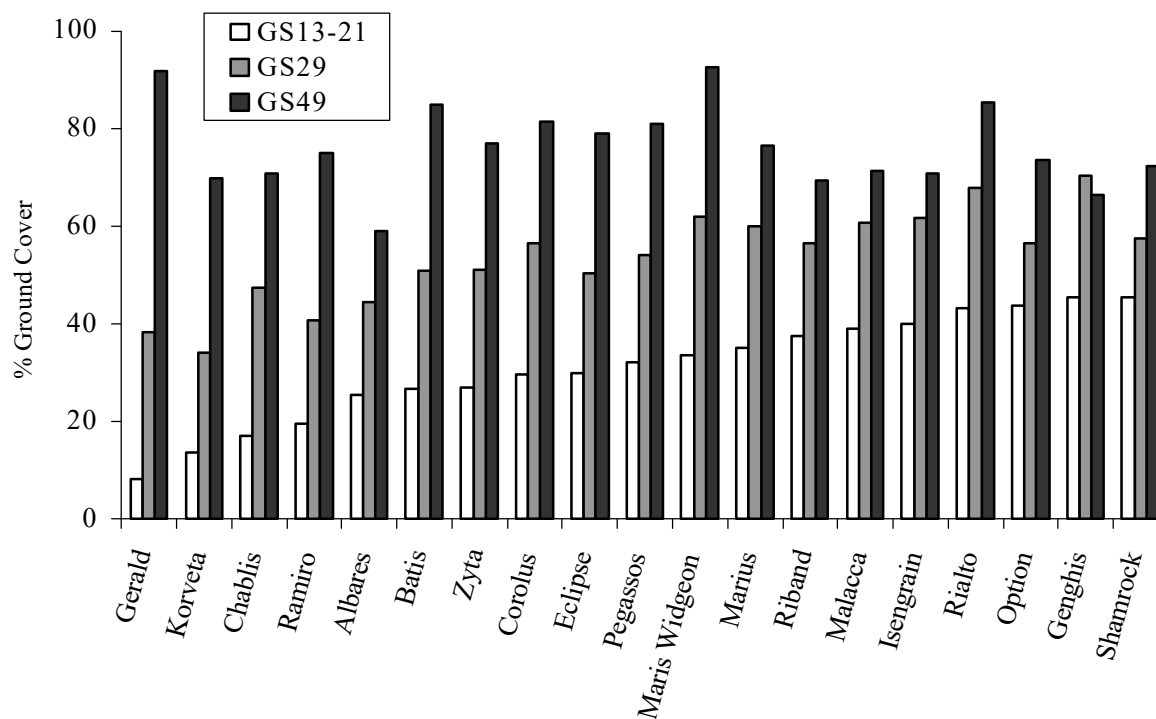


Figure 3. Crop cover by variety at growth stages GS13/21, GS29 and GS49

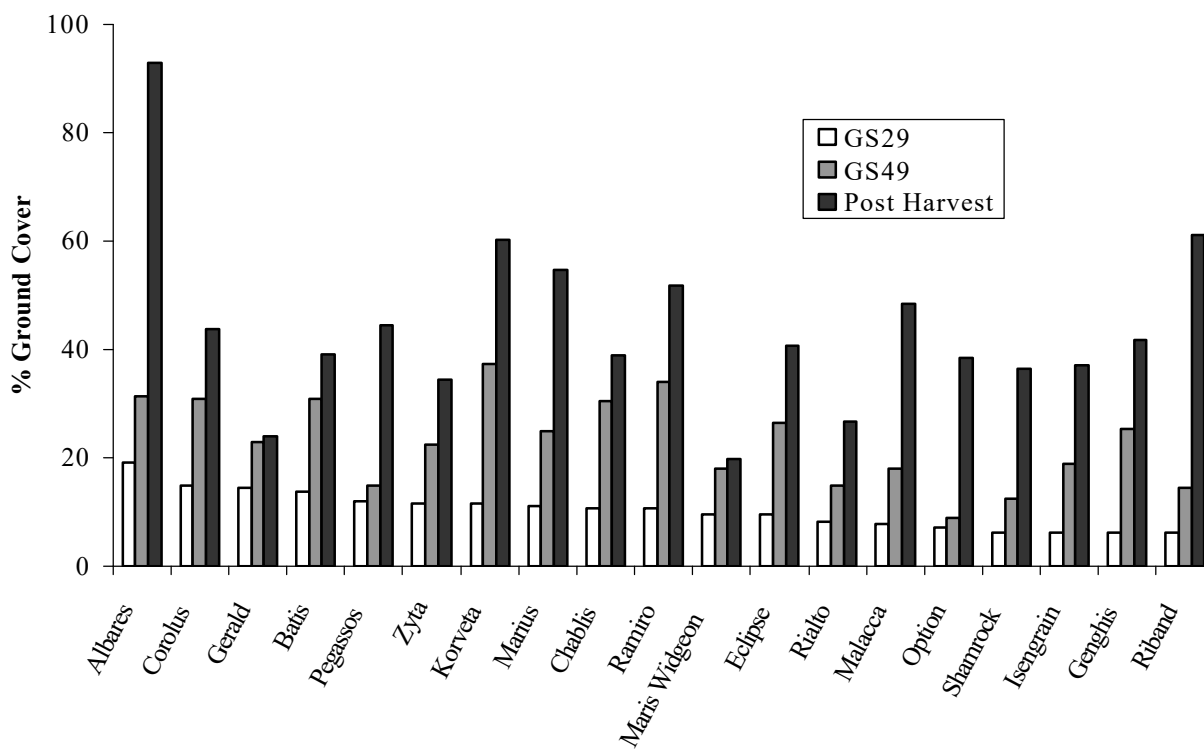


Figure 4. Weed cover in each variety at GS29, GS49 and post-harvest

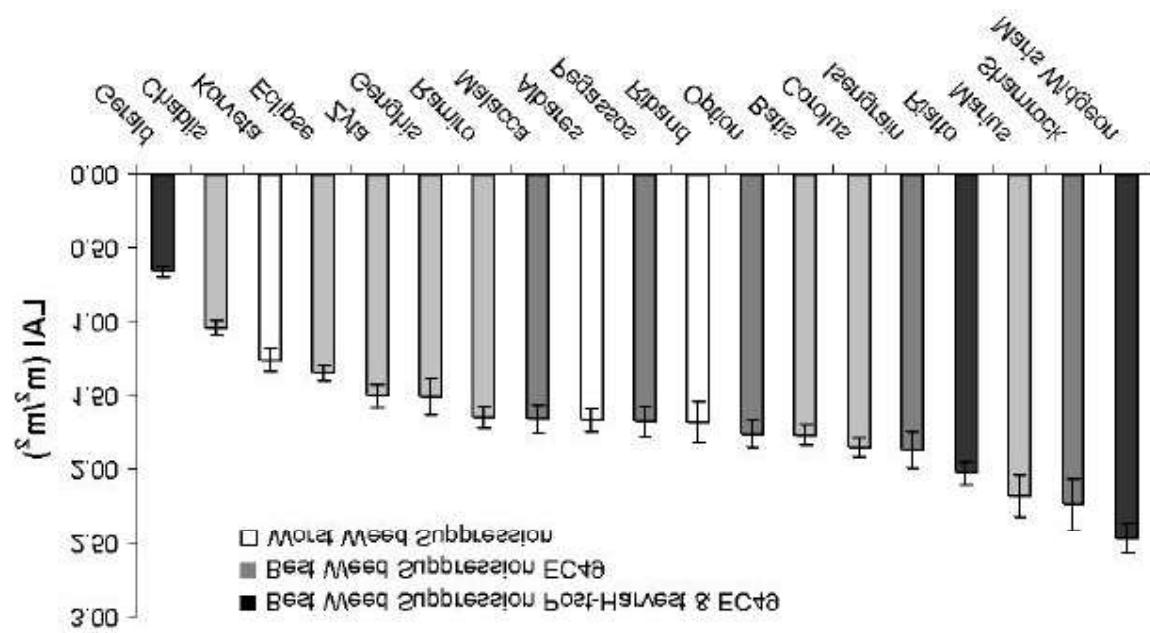


Figure 5. LAI by Sunscan assessment at GS31 and increased level of weed suppression at GS49 and later by each variety indicated by increased degree of shading (Bars = SE).